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POPULATION DYNAMICS OF *JOHNIEOPS VOGLERI* (BLEEKER) OFF BOMBAY WATERS*

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ABSTRACT

Age and growth, mortality and stock assessment of *Johnieops vogleri* (Bleeker) based on the data collected from New Ferry Wharf landing centre of Greater Bombay from 1979-80 to 1984-85, is reported here. This species attains 143 mm, 227 mm and 277 mm at the end of first, second and third year respectively. The von Bertalanffy's growth parameters estimated were as follows : $L\infty = 354$ mm, $K=0.5077$ (annual), $t_0 = -0.02032$ years and $W\infty = 586$ gm. Instantaneous rates of total, natural and fishing mortalities were estimated as $Z=2.22$, $M=1.10$ and $F=1.12$.

The present exploitation ratio (E) works out to be 0.50 and the exploitation rate (U) is 0.42. The average standing stock is estimated to be 675.175 tonnes and total stock 1681.558 t, whereas the annual average yield is 756.20 t. Maximum Sustainable Yield (MSY) was found to be 749.444 t. The present investigation indicates that the stock of *J. vogleri* is optimally exploited and any further increase in the fishing efforts is not advisable.

INTRODUCTION

SCIAENIDS roughly form 14 to 16% of the total trawl catch at New Ferry Wharf and Sassoon Docks landing centre of Greater Bombay. Occurring as a by-catch from shrimp trawl quantitatively they constitute very high proportion though economically they do not fetch much. Study on the age and growth of sciaenids have been done on *Pseudosciaena diacanthus* by Rao (1961, 1971 a) and Rao (1971), *Otolithoides brunneus* by Kutty (1961) and Jayaprakash (1978), *Pseudosciaena coibor* by Rajan (1964), *Johnieops vogleri* by Muthiah (1982) and *Johnius* (*Johnius*) *carutta* by Murty (1986). The study on the population dynamics of sciaenids is restricted to *Pseudosciaena dia canthus* (Rao, 1971 b) and *Johnius* (*Johnius*) *carutta* by Murty (1986).

The present investigation deals with the growth, mortality and yield parameters of *Johnieops vogleri* (Bleeker) which constitutes 19.56% of the total sciaenids at New Ferry Wharf.

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MATERIAL AND METHODS

Catch and effort data of commercial trawlers were collected from 1979-80 to 1984-85 from New Ferry Wharf landing centre of Greater Bombay. Weekly observation was taken for length and species composition

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and day's catch. The estimated numbers in each length groups were raised to day's and subsequently to month's catch. Length data was grouped in 5 mm class intervals for the study of growth. Scatter diagram technique (Devaraj, 1982) has been used for the present study. Growth was estimated by employing the von Bertalanffy's (1938) growth formula expressed as

$$L_t = L\infty\,(1 - e^{-k(t - t_o)})$$

Where L∞ is the asymptotic length, K is the growth coefficient and t_o is the age at which the fish would have its length zero. L∞ and K were estimated by using Ford (1933) and Walford (1946) plot of L_{t+1} against L_t given by the expression

$$L_{t+1} = L\infty\,(1 - e^{-k}) + e^{-k} L_t$$

and t_o was estimated by employing following regression :

$$-\log e \left(\frac{L\infty - L_t}{L\infty}\right) = -K t_o + K_t$$

Length-weight relationship was fitted by the method of least squares

$$W = al^b \text{ or } \log w = \log a + b.\ (\log l)$$

where W = weight in gm, l is the length in mm and 'a' and 'b' are constants.

Instantaneous rate of total mortality (Z) was estimated by length-converted catch curve method of Pauly (1982) using the relationship

$$\text{Log e } (N/\Delta t) = a + b.t$$

where Δt is the time taken to grow from the lower limit to the upper limit in each length class, 'N' is the numbers caught in each length group, 'a' is the Y-axis intercept, 'b' = Z with the sign changed and 't' is the mid-point in each length group. Here only the descending right limb of the curve is taken for the estimation of 'Z'.

Instataneous rate of natural mortality 'M' was estimated by Cushing's (1968) method using the formula

$$Z = M = \frac{1}{t_{max} - t} = \log e \frac{No}{N_{t_{max}}}$$

where N_t is the number of one year old fishes and N_{max} is the numbers at maximum age in a fish population.

'M' was also estimated by employing Pauly's (1980) formula given as

$$\text{Log } M = -0.0066 - 0.279 \text{ Log } L\infty + 0.6543 \log K + 0.4634 \log T.$$

where L∞ is in cm, K is annual and T is the mean temperature in degrees centrigrade, which was taken as 28°C from Bapat *et al.* (1982).

The fishing mortality coefficient 'F' was estimated by substituting 'Z' from 'M' *i.e.*

$$F = Z - M$$

Independent estimate of 'F' was also made following the method of Allen (1953) where U is estimated by the relationship

$U = \frac{Lc}{\bar{L}}$ where Lc is the length at first capture and $\bar{L}$ is the mean length. Once U is estimated, F is obtained by the formula

$$F = \frac{UZ}{1 - e^{-z}}$$

The rate of exploitation (U) was estimated by the equation given by Beverton and Holt (1957) and Ricker (1975) written as

$$U = \frac{F}{Z}\,(1 - e^{-z})$$

Total stock and standing stock was estimated by the relationship Y/U and Y/F respectively where Y is the yield in tonnes.

The exploitation rate (E) was estimated by the relationship

$$E = \frac{F}{Z} = \frac{F}{F + M}$$

The yield-per-recruit was estimated by employing the dynamic pool model of Beverton and Holt (1957) and Ricker (1975) given as

$$Y = FRW\infty\, e^{-M(tc-tr)} \left[\frac{1}{F+M} = \frac{3e^{-k(tc-to)}}{F+M+K} + \frac{3e^{-2k(tc-to)}}{F+M+2K} - \frac{e^{-3k(tc-to)}}{F+M+3K} \right]$$

where tr=age at entry into the fishing area and tc = age at first capture which was determined by following Beverton and Holt (1957).

The 'a' and 'b' values are in length-weight relationship with length in cm and l_o being the length in cm when the age is zero.

Maximum Sustainable Yield was estimated by Gulland's (1979) method given as

Py=Zt X 0.5 X Bt where Z_t is the exponential rate of total mortality in the year t and B_t is the standing stock.

RESULTS

Age and Growth : Leng'h frequency data collected for a period of s x years from 1979-80 to 1984-85 at New Ferry Wharf is represented

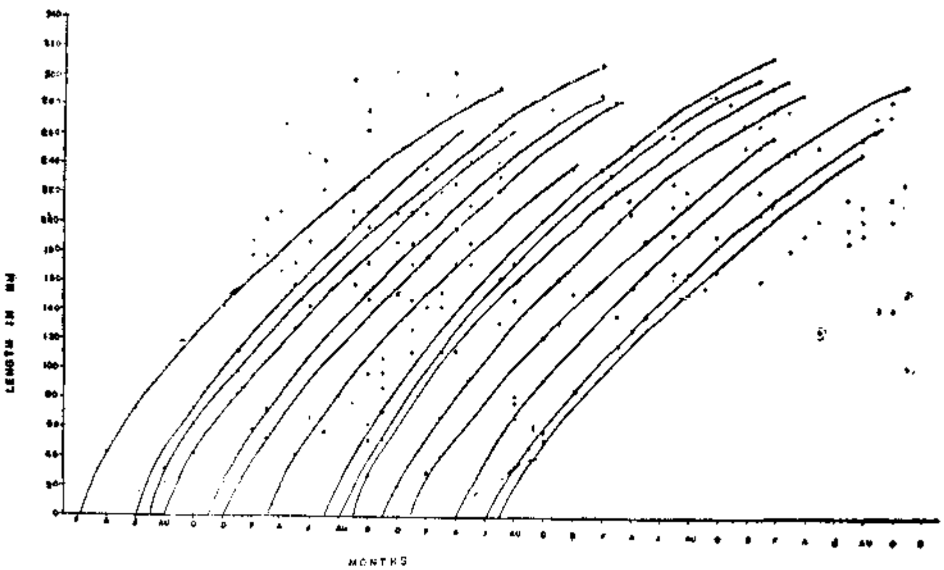

FIG. 1. Scatter diagram of length frequency data of *J. vogleri.*

in the scatter-diagram (Fig. 1). Since smaller fishes were not represented in the trawlers, samples were also collected from 'dol' netters for three years (1981 to 1983) to supplement the data. The smallest fish obtained from 'dol' and trawl net were 20 mm and 95 mm respectively. The estimated length at the end of first, second and third year was 143, 220 and 277 mm respectively. The empirical values of growth obtained by modal progression and the calculated length based on VBGF is

Potential yield-per-recruit (Y') was estimated from the equation developed by Kutty and Qasim (1968) given as

$$Y' = ae^{-M(ty-tr)}(L\infty\,(-L\infty - l_0)\,e^{-kty})b$$

where ty the optimum age of exploitation was estimated from the relation

$$e^{kty} = \frac{(L\infty - l_0)\,(b.K + M)}{ML\infty}$$

and l_o from

$$l_0 = L\infty\,(1 - e^{-k(t - t_o)}).$$

given in Fig. 2. Ford-Walford plot is presented in Fig. 3. The L_∞ was estimated as 354 mm and $K = 0.5077$ (annual). L_∞ of 354 agrees closely to the largest fish of 324 mm observed in the population. t_o was estimated as —0.02032 years. For the estimation of W_∞ length-weight studies was done for male

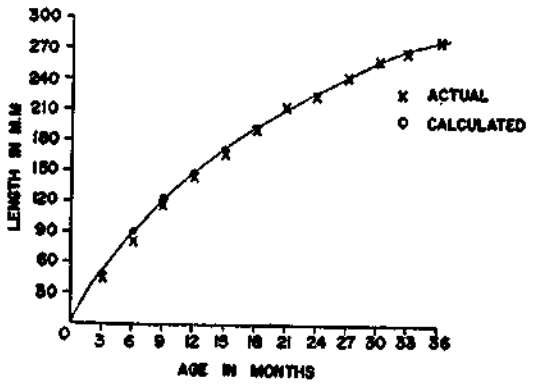

FIG. 2. von Bertalanffy growth curve for *J. vogleri*.

and females. The regression coefficients of both the sexes were tested for its significance by analysis of covariance following Snedecor and Cochran (1967). As it was found to be insignificant at 5% level the data of both the sexes were pooled together and a common formula was obtained for the estimation of W_∞.

$\text{Log } W_\infty = -5.584377 + 3.27664 \log L$ and the W_∞ estimated as 586 gm.

Mortality Estimates

Average 'Z' of 2.22 was estimated by following length-converted catch curve method (Table 1). Annual average 'Z' ranged from lowest of 1.74 in 1983-84 to highest of 2.70 in 1984-85. For the estimates of 'Z' only the descending right limb of the curve was taken (Fig. 4).

Natural mortality coefficient of 1.1 was obtained by following Cushing's and Pauly's method.

By substituting Z from M fishing mortality coefficient F was estimated as 1.12.

$$F = 2.22 - 1.1 = 1.12$$

Independent estimate of 'F' was also done by Allen's (1953) method. The average value of 'F' obtained by this method was 1.21 (Table 2). The 'F' obtained by independent estimate does not differ much from one estimated by subtracting M from Z. For further estimates of F of 1.12 was taken into consideration.

Stock Assessment

The average total stock (Y/U) and average standing stock (Y/F) was estimated as 1681.588 t and 675.175 t respectively (Table 1).

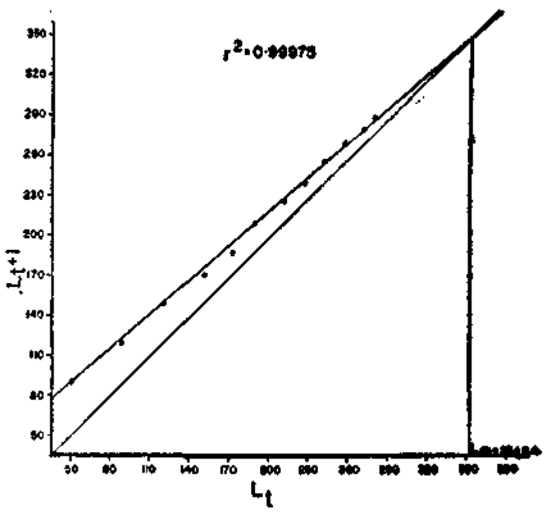

FIG. 3. Ford-Walford plot of L_t against L_{t+1}.

Yield per Recruit

The smallest fish observed from trawl-net during the present study was 95 mm. This was converted to age by VBGF and was found to 0.6 years. This was taken as t_r. Age at first capture (t_c) was estimated as 1.0 years. Yield curve was constructed at different value of 'F' keeping the age at first capture (t_c)

constant (Beverton and Holt 1957). The Yw/R at the present F of 1.12 was 28.5816 gm as compared to 30.388 gm at F_{max} of 2.0428 (Fig. 5).

Average maximum sustainable yield of 749.44 t was estimated by Gulland's method as compared to an average yield of 756.20 t (Table 1).

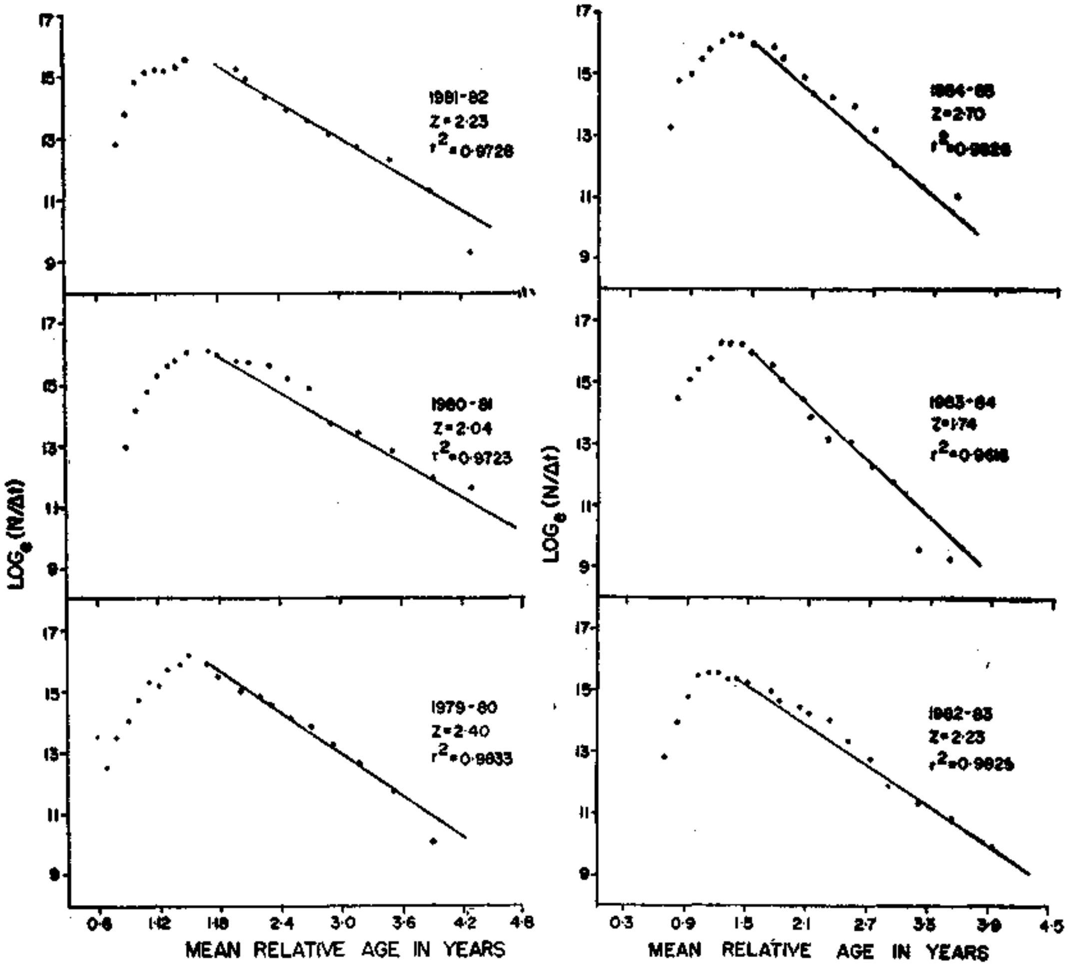

FIG. 4. Length converted catch curve for the estimation Z.

A yield isopleth diagram depicting the isolines of yield for varying levels of t_c on the Y-axis and E on the X-axis is prepared from the yield table (Beverton and Holt 1966). Both eumetric fishing curve BB′ and MSY curve AA′ converge on a point vertically above F_∞ indicating the potential yield per recruit of 37.00965 gm as the optimum age of exploitation of 1.60 years (198 mm) (Fig. 6).

DISCUSSION

The growth coefficient K is closely related to the longevity of the fish and hence the size (L_∞) it attains in its life time. Among the Indian sciaenids work has been on *Pseudosciaena coibor* (Rajan, 1964), *Pseudosciaena diacanthus* (Rao, 1961 ; Rao, 1971), *Otolithoides brunneus* (Kutty, 1961 ; Jayaprakash, 1978).

and *Johnius* (*Johnius*) *carutta* (Murty, 1986). The L∞ and K of these fishes is given in Table 3. All of them follow the inverse relationship between L∞ and K.

277 at the end of first, second and third year respectively. Muthiah (1982) assumed the fish to attain 290 mm at the end of third year. K and L∞ has not been estimated by him.

TABLE 1. *Estimation of Z, F and U, total stock, standing stock and MSY of* Johnieops vogleri (*Bleeker*)

Year		Total mortality 'Z'	Fishing mortality 'F'	Exploitation Rate 'U'	Yield (Y) in tonnes	Total stock (Y/U)	Standing stock (Y/F)	MSY
1979-80	..	2.4	1. 3	0.4925	597.998	1214.209	459.998	551.997
1980-81	..	2.04	0.94	0.4008	933.668	2329.511	993.263	1013.128
1981-82	..	2.23	1.13	0.4522	805.482	1781.251	712.815	794.788
1982-83	..	2.23	1.13	0.4522	843.084	1864.405	746. 92	832.815
1983-84	..	1.74	0.64	0.3032	627.317	2068.987	980.182	852.758
1984-85	..	2.7	1. 6	0.5527	729.638	1320.133	456.023	615.631
Average *	..	2.22	1.12	0.4497	756.197	1681.558	675.175	749.444

* Average is for Z and yield only.

Muthiah (1982) has reported that *J. vogleri* (Bleeker) from Bombay waters attains 158, 240 and 290 mm at the end of first, second and third year respectively which differs slightly

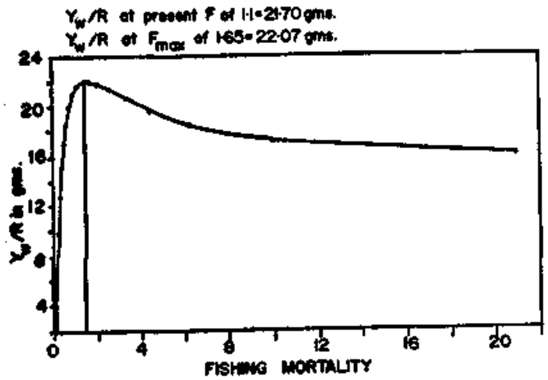

FIG. 5. Yield curve of *J. voglert.*

from the age estimated at the present investigation, where it is estimated as 143, 227 and

The problem of natural mortality coefficient 'M' has been amply discussed by many authors. Tropical multispecies fishery are often exploited and time series-data on 'Z' and efforts 'f' are generally not available. It is for this reason 'M' most often cannot be estimated by any conventional method (Pauly, 1980). Since effective efforts are difficult to obtain a number of methods are to be tried to arrive at reasonable estimate of 'M'. The estimation of 'M' by Pauly's method is reasonable in the sense it is not very different from the true values as opposed to *e.g.* estimate based on a plot of Z against efforts which can sometimes produce completely erroneous values of 'M' including negative values (Ricker, 1975). 'M' estimated by Cushing's and Pauly's method gave an identical value of M=1.1. Since independent estimate of 'F' (1.21) was close to the 'F' estimated by substituting Z from M (1.12) it further confirms the reasonable estimate of 'M' by following the above two methods. It also closely agrees to M of 1.0 for *J. carutta* estimated by Murty (1986) by following Pauly's equation as this is also a lesser sciaenid falling in the same length group (L∞=333 mm).

the M/K ratio of 1.64 for *Pennahia macropthalamus* from Manila Bay the range becomes narrower *i.e.* from 2.11 to 2.61. For *J. vogleri* it is 2.16 thus proving the constancy of M/K ratio for a family or similar taxonomic group

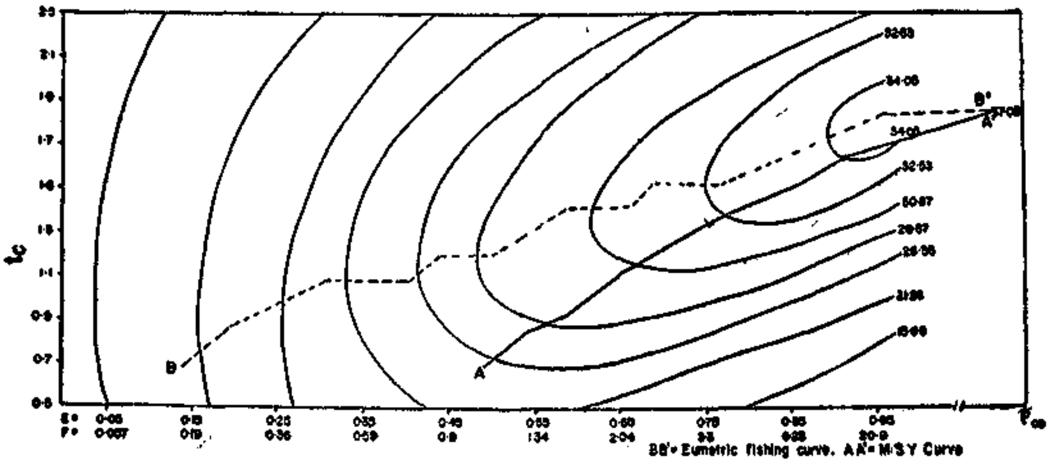

FIG. 6. Yield isopleth diagram of *J. vogleri*.

TABLE 2. *Independent estimate of 'F'*

Year	Total mortality estimate 'Z'	U (l/lc)	Estimate of F
1979-80 ..	2.4	0.4773	1.20
1980-81 ..	2.04	0.3836	1.23
1981-82 ..	2.23	0.4355	1.22
1982-83 ..	2.23	0.4355	1.08
1983-84 ..	1.74	0.2636	1.14
1984-85 ..	2.70	0.5382	1.40
Average ..	2.22	0.4256	1.21

The M/K ratio is found to be constant for closely related species and sometimes for similar taxonomic groups (Beverton and Holt, 1959; Banerjee, 1973). The M/K ratio of some of the sciaenids is given in Table 3 which shows that it ranges from 1.64 to 2.61. If we eliminate

All the species of sciaenids are landed a. by-catch of shrimp trawlers at New Ferry Wharf. The percentage of shrimps in the total catch is 33.13% and of lesser sciaenids is 14.48% (Chakraborty *et al.*, 1983). The sciaenids rank first among the by-catch. Though weight-wise they are substantial, but as far as economic returns are concerned they do not fetch much. Nevertheless, by catches are not of negligible interest to the directed fishery. The value of minor fishes can make all the difference between a profitable and non-profitable trip (Gulland, 1983). It is seen that because of the target fishery (prawns here), some of the by-catches are very adversely affected, as very small sizes of these finfishes are landed which would have grown to bigger sizes. If the size at first capture is below the current overall rate of fishing, the occurrence of the by-catch would adversely affect the future by-catch population. Suggestions based on single species is often criticised for its ignoring the interaction of species in the same ecosystem with inter-related species. It is thus essential that any assessment of the effect of proposed changes in a fishery through regulatory means like increasing or decreasing the fishing or altering the mesh size of the effect of all the species in that particular gear should be taken into consideration.

In the present investigation we have observed that the total stock of *J. voglerl* is 1681.558 t and standing stock 675.175 t as compared to as average yield of 756.20 tonnes. The yield isopleth diagram shows that the eumetric fish curve and MSY curve meet at F∞ giving potential yield per recruit of 37.00965 gm at optimum age of exploitation of 1.60 years. But beyond E 0.70 the curve ascends very slowly almost reaching an asymptote. At the present F of 1.12 the E has already reached 0.50. Gulland (1971) has suggested that E=0.5 which he terms as Eopt should be maintained for all stocks as E beyond 0.5 is harmful for the stock.

Since at the moment the stock of *J. vogleri* is optimally exploited any further increase in the fishing mortality would be detrimental to the stock.

TABLE 3. *M/K ratio of a few species of sciaenids*

Species	Country/Place of occurrence	Body size/ L in cms	K	M	M/K	Reference/Author
D. russelli	San Miguel Bay	17.5*	0.95	2.01	2.11	Ingles and Pauly, 1984
Otolithus ruber	San Miguel Bay	25.5*	0.44	1.025	2.32	Ingles and Pauly, 1984
Pennahia macropthala mus	Manila Bay	26.5*	1.4	2.30	1.64	Ingles and Pauly, 1984
Pennahia macropthalamus	San Miguel Bay	20.0	0.6	1.43	2.38	Ingles and Pauly, 1984
Pseudosciaena diacanthus	Arabian Sea—Bombay-Saurashtra, India	122.14	0.315	0.83	2.61	Rao, 1971 b
Johnius carutta	Bay of Bengal, Kakinada, India	33.33	0.44	1.0	2.27	Murty, 1986
Johnieops vogleri	Arabian Sea, Bombay waters, India	35.4	0.5077	1.1	2.16	Present investigation

* Indicates the largest fish observed in the population.

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